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R. R. ROMANOWSKI, JR.
and
J. S. TANAKA

HAWAII AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF HAWAII

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Secondary Herbicide Screening Trials with Leguminous Vegetable Crops in Hawaii

R. R. Romanowski, Jr.,[1] and J. S. Tanaka[2]

INTRODUCTION

The herbicide trials reported herein were conducted to evaluate herbicides for use with the following leguminous vegetable crops in Hawaii: Pole Bean (*Phaseolus vulgaris* 'Hawaiian Wonder'), Lima Bean (*Phaseolus lunatus* 'Fordhook 242'), Edible Podded Pea (*Pisum sativum* var. macrocarpon 'Manoa Sugar B6'), and vegetable Soybean (*Glycine Max* 'Bansei').

Since the above cultivars were different from most grown in the continental United States and the herbicide screening trials conducted on the above crops were largely in temperate regions rather than areas with subtropical and tropical climates, it was necessary to evaluate the selectivity of the herbicides before recommendations could be made for local use. A majority of the herbicides tested were either registered by the Federal Food and Drug Administration for use in the United States or appeared to be likely candidates for future registration.

[1]Dr. R. R. Romanowski, Jr., is Assistant Horticulturist at the Hawaii Agricultural Experiment Station.

[2]J. S. Tanaka is Junior Horticulturist at the Hawaii Agricultural Experiment Station.

MATERIALS AND METHODS

The herbicide trials were installed at the five representative major crop-producing areas listed in table 1. A wide variety of climatic regions and soil types were used to advantage to obtain a broad spectrum of herbicidal response. Pole beans received primary consideration since they comprised the largest acreage of podded vegetable crops in Hawaii. Table 1 lists pertinent information related to the test locations and experiments conducted.

TABLE 1. Location, Soil Type, and Crops Tested

Experiment Station	Island	Elevation	Soil Type	Experiment No. and Crops Tested
Poamoho Experimental Farm	Oahu	870 feet	Wahiawa silty clay	Expt. No. 1—Lima Bean, Pea, Pole Bean, and Soybean
Kauai Branch Station	Kauai	500 feet	Halii gravelly silty clay	Expt. No. 2—Pole Bean
Waimanalo Experimental Farm	Oahu	70 feet	Waimanalo silty clay	Expt. No. 3—Pole Bean Expt. No. 4—Pole Bean and Soybean Expt. No. 5—Pea
Manoa Campus Farm	Oahu	90 feet	Manoa clay loam	Expt. No. 6—Pea
Maui Branch Station	Maui	2,800 feet	Waimea fine sandy loan	Expt. No. 7—Pea

Cultural Practices

The crops were grown in a majority of the experiments using cultural practices similar to those commonly in use by island farmers. This was especially true in Experiments 1, 4, 5, and 6, where furrow irrigation was practiced. The seeds were sown on the furrow slopes approximately 4 to 6 inches from the furrow bottom to conserve water utilization in soils with high infiltration and drainage rates. This is a system that does afford a somewhat complex situation when herbicides are used for weed control.

The term "furrow" is used in this report to designate the entire furrow area, and "shoulder" is used to describe the level area between furrows.

A "cultivated check" was maintained in most experiments to prevent a weed × crop interaction. Similarly, the weeds were removed by hand in all treatments when the herbicides were no longer effective. The other routine cultural practices conformed to those suggested by the Hawaii Cooperative Extension Service.

Treatment Applications

A majority of the herbicides were applied as sprays immediately after seed-sowing with a back-mounted fiberglass sprayer. The sprays were applied at 30 p.s.i. (pounds per square inch of pressure) and 40 gal/acre (gallons per acre) of herbicidal mixture. Water was used as the diluent to prepare the treatment mixtures which were made from the commercially available emulsifiable concentrates and wettable powders. Rates of chemicals used in the trials were expressed as pounds of active ingredient per acre.

Eptam and Tillam were sprayed before seed-sowing in Experiments 2 and 3 and immediately incorporated into the soil with tillage implements. Methyl bromide was applied in Experiment 3 as a gas which was released under a plastic cover. The herbicides in Experiment 6 were applied at crop emergence in one series of treatments, and in another series when the peas were 5 inches in height. Small weeds were present at the time of spray application.

Methods of Evaluating and Reporting the Experimental Results

An objective method was used in only one of seven experiments to measure actual counts of weed response to the herbicides. A more rapid and time-saving subjective method rating system was used to record the weed control and crop tolerance to the herbicides when applicable.

Weed Control Ratings	*Crop Tolerance Ratings*
1 no control	1 no injury
2 slight control	2 slight injury
3 fair control	3 moderate injury
4 good control—commercially acceptable	4 severe injury
5 complete control	5 dead

TABLE 2. Chemicals Used in the Experiments

Trade Name[1]	Registered for Use on the Following Crops	Temporary Designation or Common Name	Chemical Name
Chloro-I.P.C.	Pole and Lima Beans, Soybeans, Peas	C.I.P.C.	isopropyl N-(3-chlorophenyl) carbamate
Dacthal W-75	Pole and Lima Beans, Soybeans	DCPA	dimethyl ester of tetrachloro-terephthalic acid
Dowfume MC-2	Pole and Lima Beans, Soybeans	methyl bromide	methyl bromide with chloropicrin
Dymid		diphenamid	N,N-dimethyl-2,2-diphenyl-acetamide
Eptam	Pole Beans	EPTC	ethyl di-n-propylthiocarbamate
Premerge	Pole and Lima Beans, Soybeans, Peas	DNBP, amine	4,6-dinitro-o-sec-butylphenol (triethanolamine salt)
Randox	Pole and Lima Beans, Soybeans	CDAA	2-chloro-N,N-diallylacetamide
Sinox PE	Pole and Lima Beans, Soybeans, Peas	DNBP, amine	Same as Premerge
Tillam		PEBC	n-propyl N-ethyl-N-butylthiol-carbamate
Treflan	Pole and Lima Beans, Soybeans	trifluralin	2,6-dinitro-N,N-di-n-propyl-$\alpha\alpha\alpha$-trifluoro-p-toluidine
Vegadex	Pole and Lima Beans, Soybeans	CDEC	2-chloroallyl diethyldithio-carbamate

[1]Active ingredients of chemical formulations: Emulsifiable concentrates (pounds per gallon)—Premerge and Sinox PE 3 pounds; Chloro-I.P.C., Randox, Treflan, and Vegadex 4 pounds; Eptam and Tillam 6 pounds; Wettable powders—Dacthal 75% and Dymid 80%; Gases—methyl bromide with chloropicrin 1 pound/container.

TABLE 3. Scientific Names of the Weed Species Discussed in this Report

Common Name (Hawaiian Islands)	Scientific Name
Grasses	
foxtail, bristly	*Setaria verticillata*
lovegrass	*Eragrostis pectinacea*
nutsedge	*Cyperus rotundus*
wiregrass	*Eleusine indica*
Broadleaves	
amaranth, spiny	*Amaranthus spinosus*
amaranth (spineless species)	*Amaranth hybridus*
apple of Peru	*Nicandra physalodes*
joee	*Stachytarpheta cayannensis*
popolo	*Solanum nodiflorum*
purslane (pigweed)	*Portulaca oleracea*
pualele (red and orange)	*Emilia* spp.
richardia	*Richardia scabra*
sow thistle	*Sonchus oleraceus*
spurge, garden	*Euphorbia hirta*
stagger weed	*Stachys arvensis*
swinecress	*Coronopus didymus*

The procedure for the subjective measurements was to study all of the checks in an experiment before the ratings were made. Subsequently, all plots were rated without knowledge of the treatments applied. Because of variable weed stands and varied crop plant growth the treatment means presented in this report often deviate from a rating of "1" for the check plots.

The reporting of the experimental results is contained in two major sections. The results presented in the General Results and Discussion are supplemented by data presented in the Appendix.

All data were reported in the Appendix as treatment means. The L.S.D. (least significant difference) was selected as the statistic for ease of comparing treatment means. It was used largely to compare the herbicide treatment means to the cultivated check when considering crop tolerance and to the uncultivated check when interpreting weed response.

RESULTS

The results clearly show that there are distinct possibilities of using herbicides for weed control on the leguminous vegetable crops in Hawaii. Of special interest are the data which show that certain mainland United States recommendations cannot be used in Hawaii because of edaphic and/or climatic conditions. The following generalizations of the herbicidal responses were made from the information contained in the Appendix.

Herbicide and Experiment No.	*Crop Tolerance*	*Weed Control*
Chloro-I.P.C. (1,2)	Severe injury to lima beans and peas with no injury to soybeans; none to moderate injury to pole beans.	Poor to fair weed control at the two test locations.
Dacthal W-75 (4,7)	No injury to pole beans and soybeans at the Waimanalo Farm Station; safest of all herbicides tested on peas at the Kula Station where severe injury was encountered with most other herbicides.	Excellent weed control on broadleaved weeds at Waimanalo but only fair control experienced at the Kula Station.
Dowfume MC-2 (3)	No injury to pole beans.	Excellent control of all weed species.
Dymid (7)	Almost complete eradication of peas at the Kula Station.	Excellent weed control.

(Continued)

Herbicide and Experiment No.	*Crop Tolerance*	*Weed Control*
Eptam (2,3)	No injury to pole beans in both tests.	Excellent nutsedge and wiregrass control with poor broadleaved weed control.
Premerge or Sinox PE (1,2,4,5,6,7)	No phytotoxicities were observed when applied up to the 6 lb/acre rate immediately after sowing on pole beans, soybeans, and lima beans. Moderate to severe pea injury when applied at sowing in most experiments; however, no pea injury was inflicted when applied up to the 3¾ lb/acre rate at crop emergence. On the contrary, pole beans and soybeans were injured when the chemical was applied at crop emergence in Experiment 4. Moderate to severe foliar injury was observed when sprayed over pea plants 5 inches in height at the 2½ to 3¾ lb/acre rates.	Excellent broadleaved weed control of all species encountered in the experiments. The grass control was fair to good when the 6 to 9 lb/acre rates were used and poor at the lower rates.
Randox (1,4,5,7)	Slight to moderate injury was noted in two of three experiments on peas and one of two experiments with pole beans. No injury was found on soybeans in two tests and lima beans in one experiment.	Excellent weed control was obtained in two experiments at Waimanalo. Poor to fair weed control was recorded at the Poamoho Farm and Kula Station, respectively.
Tillam (3)	No injury to pole beans in one experiment.	Excellent nutsedge and wiregrass control; no control of amaranth and poor to fair control of pigweed (purslane).

(Continued)

(Continued from page 9)

Herbicide and Experiment No.	*Crop Tolerance*	*Weed Control*
Treflan (4,7)	When used as a preemergence spray at 6 lb/acre severe injury was noted on soybeans and evidence of slight injury to pole beans. A moderate reduction in the fresh weight of pea plants was found at the Kula Station when used as a preplant soil incorporated treatment at 2 lb/acre.	Excellent weed control at the 6 lb/acre rate at Waimanalo and fair weed control when soil incorporated at 2 lb/acre at the Kula Station.
Vegadex (1,2,4,7)	Vegadex at 4 to 6 lb/acre was nontoxic to pole beans, soybeans, and lima beans when applied after seed sowing. The peas were injured in an experiment at the Kula Station under severe test conditions and no injury was detected at the Poamoho Farm in a single experiment.	Good to excellent weed control was experienced at three of the test locations. Poor control of popolo, pualele, tarweed, and joee was found at the Kauai Station.
C.I.P.C. + Premerge or Sinox PE (1)	Severe injury to pole beans, lima beans, and peas; no injury to soybeans.	Fair weed control but not commercially acceptable.
Randox + Premerge or Sinox PE (1,4,7)	Safe on all crops at Poamoho, and moderate injury on pole beans and peas at Waimanalo Farm; only slight soybean injury at Waimanalo.	Excellent weed control at Poamoho and Waimanalo with only fair weed control at the Kula Station.
Vegadex + Premerge or Sinox PE (2,4,7)	No injury to pole beans at two locations and soybeans in one test; severe injury to peas at the Kula Station.	Excellent control of all weeds in the three tests.
Vegadex + Randox (4,7)	Moderate to severe injury to pole beans and peas with no injury to soybeans.	Excellent weed control at the two locations.

DISCUSSION AND SUMMARY

Of the chemicals tested, Dacthal, Eptam, Randox, Vegadex, and Premerge or Sinox PE can be used to advantage by farmers when considering both weed control and crop tolerance. The other herbicides tested need further experimentation to prove their worth with the leguminous vegetable crops in Hawaii.

Premerge or Sinox PE was the most satisfactory herbicide for the control of broadleaved weed species in the experiments. Its major attribute was the commercially acceptable control of all broadleaved species encountered in the experiments as contrasted to the one or more species left by each of the other herbicides. Randox or Vegadex mixed with Premerge or Sinox PE greatly improved the grass control. The results showed that Premerge or Sinox PE should not be applied over pea foliage in the tropics and when applied immediately after seed-sowing, rates exceeding 6 lb/acre should be used with caution on all the crops tested.

A second interesting observation was severe crop phytotoxicity obtained with peas at the Kula Branch Station contrasted to considerably less injury at the other test locations. Excluding soil differences, the cool temperatures which prevailed for the duration of the experiment at Kula may have been largely responsible for the adverse results. The maximum daily air temperature range in Kula varied from 66° to 74° F. and minimum temperatures from 50° to 64° F. over the experimental period. The other tests were conducted at lower elevations which had considerably higher temperatures. A complexity of other variables may have contributed to the results, nevertheless, this single experiment does show the need for extreme caution when using herbicides for the first time at the higher elevations in Hawaii.

When considering crop phytotoxicities, weed control, and Federal registrations for crop use, the following herbicides or combinations thereof are recommended for trial use by Hawaii farmers (table 4).

The use of Vegadex is recommended in preference to Randox whenever possible to overcome temporary burning skin discomfort caused by Randox to many users under tropical conditions. Randox is superior to Vegadex on the Waimanalo soil, but Vegadex performs equally well on many other island soils.

TABLE 4. Recommended Herbicides for *Trial* Use

Herbicide (pounds active/acre)	Time of Application	Suggested Crops			
		Peas	Lima beans	Pole beans	Soybeans
Eptam 3 lb.	Preplant soil incorporated			+	
Dacthal 6 to 10½ lb.	Preemergence to crop and weeds			+	+
Premerge or Sinox PE 6 lb.	Preemergence to crop (small weeds may be present)		+	+	+
Premerge or Sinox PE 3 to 4 lb.	Spray as plants are breaking ground. (Small weeds may be present)	+			
Randox 4 to 6 lb.	Preemergence to crop and weeds		+	+	+
Vegadex 4 to 6 lb.	Preemergence to crop and weeds		+	+	+
Vegadex 4 lb. + Premerge or Sinox PE 3 lb.	Preemergence to crop and weeds			+	+

RELATED LITERATURE

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APPENDIX

EXPERIMENT NO. 1

(Permanent file copy WC-2)
Poamoho Experimental Farm Field E-1

Legume crops: Soybean (Bansei), Pea (Manoa Sugar B6), Pole Bean (Hawaiian Wonder), and Lima Bean (Fordhook 242).

Experimental design: Randomized complete block, 4 replications, plot size 5 ft. × 20 ft. (Treatment design–Factorial 4 × 12).

Experimental procedure: Field preparation Dec. 19, 1961; Date of sowing Dec. 20, 1961; Treatment application Dec. 22, 1961.

Climatic conditions: *Rainfall:* Dec. 21, 1961–.30 inch, 24–.01, Jan. 1, 1962–.02 inch, 5–.15, 7–2.28, 8–.21, 14–.05.

Irrigation: Furrow irrigated on Dec. 22, 28, and Jan. 3.

Weed species: Most prevalent: *grasses*–wiregrass, lovegrass; *broadleaves*–richardia, spineless amaranth.

Trace amounts; *broadleaves*–purslane, sow thistle, swinecress, stagger weed.

Results: See table 1.

Discussion and Summary:

Crop tolerance: Chloro-I.P.C. used alone and in combination with Sinox PE caused severe injury to lima beans and peas, with indications of moderate injury to snapbeans. The edible soybean variety, Bansei, was not injured by any of the herbicides under the test conditions. Sinox PE, Sinox PE + Randox, Randox, and Vegadex were safe on the four plant species included in the experiment.

Weed control: Vegadex and Sinox PE + Randox were the only two treatments which controlled the weeds satisfactorily.

TABLE 1. Crop tolerance and weed control response to the herbicides, Poamoho Experimental Farm, Experiment No. 1

Treatment (pounds per acre)	Crop Tolerance (February 12) Total fresh weight of plants per 6 ft. of row, Ounces: Pole bean	Lima bean	Soybean	Peas	Weed Rating[1] January 17
1. Check	10.5	24.5	10.5	16.5	1.3
2. Sinox PE 4 lb.	9.0	19.0	9.5	22.0	2.3*
3. Sinox PE 6 lb.	11.0	24.5	11.5	10.5	2.5*
4. Sinox PE 8 lb.	12.5	16.5	8.0	13.8	3.0**
5. Vegadex 4 lb.	14.0	29.0	11.5	19.0	4.0**
6. Vegadex 6 lb.	17.0	21.5	17.0	15.5	4.0**
7. Randox 4 lb.	8.0	21.5	13.5	19.5	2.5*
8. Randox 6 lb.	12.0	23.5	14.5	20.5	2.8**
9. C.I.P.C. 4 lb.	6.3	12.0**	12.5	9.0	3.5**
10. C.I.P.C. 6 lb.	8.0	5.0**	9.5	10.0	3.8**
11. Sinox PE 4 lb. + C.I.P.C. 4 lb.	4.3	8.5**	11.0	2.8**	3.5**
12. Sinox PE 4 lb. + Randox 4 lb.	9.5	20.0	13.5	19.0	4.0**
L.S.D. 5% (1%)	8.1(10.6)	8.1(10.6)	8.1(10.6)	8.1(10.6)	1.0(1.4)

[1]Weed rating scale: 1—no control, 2—slight, 3—fair, 4—good (commercially acceptable), 5—complete control. The weed data were summarized over all the crops and analyzed as a randomized complete block experiment with 16 replicates.

*Significantly different from the check at 5% level (**1% level).

EXPERIMENT NO. 2

(Permanent file copy WC-13C)
Kauai Branch Station Field D

Crop: Pole Bean (Hawaiian Wonder).

Experimental design: Randomized complete block, 3 replications, plot size 4 ft. × 20 ft.

TABLE 2. Pole bean tolerance and weed response to herbicides, Kauai Branch Station, Experiment No. 2

Treatment (pounds per acre)	Pole Bean Response		Weed Control
	Crop rating[1] June 1	Total yield (pounds per plot)	Weed rating June 1 (4 weeks)
1. Check	2.3	36.0	1.0
2. Ve gadex 4 lb.	2.3	41.3	1.7
3. Vegadex 6 lb.	2.0	40.7	2.3*
4. Sinox PE 6 lb.	1.7	43.5*	4.0**
5. Sinox PE 4 lb. + Vegadex 4 lb.	1.7	47.6**	4.7**
6. Eptam 3 lb. (Soil incorporated)	2.3	39.8	1.3
7. C.I.P.C. 3 lb.	1.3	45.8**	2.3*
L.S.D. 5%(1%)	n.s.	5.8(8.1)	1.0(1.4)

[1]Crop rating: 1—no injury, 2—slight, 3—moderate, 4—severe, 5—dead. Weed rating: 1—no control, 2—slight, 3—fair, 4—good (commercially acceptable), 5—complete.

*Significantly different from the check at the 5% level (**1% level).

Experimental procedure: Field preparation May 2, 1962; Field sowing May 3; Treatment application May 3.

Climatic conditions: *Rainfall (over .10 inch):* May 3—.20 inch, 4—.26, 7—1.17, 8—.36, 9—.12, 10—.36, 13—.13, 15—.43, 16—1.30, 17—.35, 18—.22, 19—.17, 20—.14, 21—.24, 22—.10, 23—.72, 27—.12.

Weed species: Most prevalent: *broadleaves*—popolo, red pualele, orange pualele, tarweed, sow thistle, and joee.

Results: See table 2.

Discussion and Summary:

Crop tolerance: No crop phytotoxicities were experienced with the herbicides included in this trial.

Weed control: Sinox PE and Sinox PE + Vegadex provided excellent weed control of the broadleaved species. The weed species contained in this experiment are extremely tolerant to most herbicides available for use with vegetable crops. Vegadex, Eptam, and C.I.P.C. did not control the weeds.

EXPERIMENT NO. 3

(Permanent file copy WC-20)
Waimanalo Experimental Farm Field A-2

Crop: Pole Bean (Hawaiian Wonder).

Experimental design: Randomized complete block, 3 replications, plot size 3 ft. × 30 ft.

Experimental procedure: Field preparation Oct. 8, 1962; Date of planting Oct. 12; Treatment applications—Tillam and Eptam sprayed on Oct. 8 and immediately tillivated into the soil surface. Replicates 1 and 2 fumigated with Dowfume (methyl bromide) on Oct. 8 and replicate 3 on Oct. 9.

Climatic conditions: *Rainfall (over .10 inch):* Oct. 22—.93 inch, 23—.14, Nov. 27—.10.

Irrigation (overhead): Nov. 2, 9, 14, 19, 21, 28, Dec. 3, and 10.

Weed species: Most prevalent: *grasses*—wiregrass, nutsedge; *broadleaves*—purslane and spineless amaranth.

Results: See table 3.

Discussion and Summary:

Crop tolerance: Dowfume, Eptam, and Tillam are herbicides recommended for the control of nutsedge. The latter is not recommended for use with beans, but as shown by the experimental results all three herbicides were safe when used on the Hawaiian Wonder variety.

Weed control: Weed counts recorded one month after treatment showed excellent control of nutsedge and wiregrass with all of the herbicides. Eptam was not effective on purslane and spineless amaranth; whereas Tillam was not effective on the amaranth and only partially effective on the purslane. The Dowfume and Eptam plots were relatively free of nutsedge 17 weeks after treatment.

TABLE 3. Pole bean tolerance and weed control response to the herbicides, Waimanalo Experimental Farm, Experiment No. 3

Treatment	Crop Tolerance		Weed Response				
	Nov. 21	Nov. 29	Nov. 7, 1962				Feb. 4, 1963
			No. of weeds per square foot[2]				(17 weeks)
	Injury rating[1]	Total fresh weight of plants (pounds)	Nutsedge	Wiregrass	Purslane	Spineless Amaranth	Nutsedge
1. Check	1.3	2.6	3.0	7.9	56.9	6.9	3.3
2. Dowfume 1 lb. per 100 sq. ft.	1.0	2.2	0.0**	0.2**	0.7**	0.2**	0.3**
3. Eptam 3 lb. per acre (soil incorporated)	1.0	3.5	0.1**	0.2**	41.9	7.0	0.5**
4. Tillam 4 lb. per acre (soil incorporated)	1.0	3.9	0.2**	0.1**	26.2*	6.4	2.2
L.S.D. 5%	n.s.	n.s.	1.5	3.6	25.4	3.6	1.8
L.S.D. 1%			2.3	5.4	38.4	5.5	2.7

[1]Rating scale: 1—no injury, 2—slight, 3—moderate, 4—severe, 5—dead.

[2]An average of four readings per plot.

*Significantly different from the check at the 5% level (**1% level).

EXPERIMENT NO. 4

(Permanent file copy WC-27)
Waimanalo Experimental Farm Field C-3

Crops: Pole Bean (Hawaiian Wonder) and Soybean (Bansei).

Experimental design: Randomized complete block, 3 replications, split plot—main plot 5 ft. × 40 ft. herbicides, sub-plot 5 ft. × 20 ft. crops.

Experimental procedure: Field preparation Oct. 25, 1962; Field sowing Oct. 26; Treatment applications—Premerge 3 lb. applied on Oct. 31 at time of emergence, all other treatments Oct. 27.

TABLE 4. Crop tolerance and weed control ratings recorded for the various species, Waimanalo Experimental Farm, Experiment No. 4

Treatment (pounds per acre)	Crop Tolerance December 6 Fresh weight of plants per 12-ft. row (lb.)		Weed Rating[1] December 11			
	Pole bean	Soybean	Spiny Amaranth	Purslane	Popolo	Wiregrass
1. Check, uncultivated	5.0	1.9	1.3	1.0	1.0	1.0
2. Check, cultivated	5.0	2.4	2.7	2.0	3.0	2.3
3. Premerge 6 lb.	4.1	2.3	3.3	5.0	5.0	4.0
4. Premerge 9 lb.	4.3	1.9	5.0	4.7	5.0	4.3
5. Premerge 3 lb. (crop emergence)	2.8**	1.4	3.3	4.0	4.7	2.7
6. Randox 4 lb.	3.8	1.8	3.7	4.3	4.3	4.7
7. Randox 6 lb.	3.1**	1.4	4.3	4.0	4.7	5.0
8. Vegadex 4 lb.	4.4	2.5	4.0	4.0	4.0	3.7
9. Vegadex 6 lb.	4.9	2.3	4.0	4.7	4.0	4.3
10. Vegadex 3 lb. + Premerge 3 lb.	3.7	2.2	4.3	5.0	5.0	4.7
11. Randox 3 lb. + Premerge 3 lb.	2.8**	1.4	4.3	4.3	5.0	5.0
12. Vegadex 3 lb. + Randox 3 lb.	2.9**	1.9	4.3	5.0	5.0	4.7
13. Dacthal 6 lb.	4.5	2.4	4.7	4.7	4.3	3.7
14. Trifluralin 6 lb.	3.9	0.8	5.0	5.0	5.0	5.0
L.S.D. 5%	1.4	n.s.	1.4	1.1	1.2	1.1
L.S.D. 1%	1.9	n.s.	1.9	1.4	1.6	1.4

[1]Weed rating scale: 1—no control, 2—slight, 3—fair, 4—good (commercially acceptable), 5—complete. Weed data taken only on main plots; therefore, the analysis of variance computed as a standard randomized complete block rather than split plot.

*Formulation significantly different than the cultivated check at the 5% level (**1% level).

Climatic conditions: *Rainfall (over .10 inch):* Oct. 23—.14 inch, Nov. 27—.10, Dec. 1—.10, 13—1.63.

Irrigation: Furrow irrigated on Nov. 2, 9, 14, 19, 21, 26, and Dec. 3.

Weed species: Most prevalent: *grass*—wiregrass; *broadleaves*—spiny amaranth, purslane, popolo.

Results: See table 4.

Discussion and Summary:

Crop tolerance: Trifluralin at 6 lb/acre was the only herbicide that injured soybeans. Randox used alone and in combination with Premerge and Vegadex caused a reduction in plant fresh weight of the pole beans. Similarly, the low rate of Premerge 3 lb/acre applied at crop emergence resulted in an excessive reduction in growth of the pole beans.

Weed control: Dacthal and the low rates of Vegadex and Premerge did not provide commercially acceptable wiregrass control; whereas the low rates of Randox and Premerge resulted in incomplete control of spiny amaranth. The control of purslane and popolo was excellent with all the herbicides tested.

EXPERIMENT NO. 5

(Permanent file copy WC-28)
Waimanalo Experimental Farm Field C-2

Crop: Pea (Manoa Sugar B6).

Experimental design: Randomized complete block, 3 replications, plot size 5 ft. × 20 ft.

Experimental procedure: Field preparation Oct. 25, 1962; Field sowing Oct. 26; Treatment applications–Sinox PE Treatments 6 and 7 applied on Oct. 31, all other treatments Oct. 27.

Climatic conditions: *Rainfall (over .10 inch):* Oct. 23–.14 inch, Nov. 27–.10, Dec. 1–.10, 13–1.63.

Irrigation: Furrow irrigated on Oct. 31, Nov. 9, 14, 19, 21, 26, 30, Dec. 3, and 10.

Weed species: Most prevalent: *grass*–wiregrass; *broadleaf*–spiny amaranth.

Trace amounts: *Broadleaves*–purslane and garden spurge.

Results: See table 5.

TABLE 5. Pea tolerance and weed control ratings recorded for the various species, Waimanalo Experimental Farm, Experiment No. 5

Treatment (pounds per acre)	Pea Response		Weed Rating[1] December 11				
	Crop rating Nov. 21	Total fresh weight of plants per 12 ft. of row (lb.)	Wiregrass	Spiny Amaranth	Purslane	Popolo	Garden Spurge
1. Check, uncultivated	1.0	3.1	1.0	1.0	1.3	2.3	2.3
2. Check, cultivated	1.0	3.4	2.3	2.7	2.7	4.0	4.3
3. Randox 4 lb.	1.3	3.8	4.3	3.7	5.0	5.0	5.0
4. Randox 6 lb.	2.0	2.5	4.7	4.3	4.3	5.0	4.7
5. Randox 3 lb. + Premerge 3 lb.	2.0	2.5	5.0	5.0	5.0	5.0	4.7
6. Sinox PE 2¼ lb. (crop emergence)	1.0	3.4	2.0	4.7	5.0	5.0	5.0
7. Sinox PE 3¾ lb. (crop emergence)	1.7	2.5	2.7	4.3	5.0	5.0	4.7
8. Sinox PE 6 lb.	2.0	2.6	3.0	5.0	5.0	5.0	5.0
9. Sinox PE 9 lb.	3.0	2.0	4.0	5.0	5.0	5.0	5.0
L.S.D. 5%	0.8	n.s.	0.3	0.8	1.1	0.8	0.8
L.S.D. 1%	1.1		0.5	1.1	1.5	1.1	1.1

[1]Crop rating: 1—no injury, 2—slight, 3—moderate, 4—severe, 5—dead. Weed rating: 1—no control, 2—slight, 3—fair, 4—good (commercially acceptable), 5—complete control.

Discussion and Summary:

Crop tolerance: Sinox PE at the high rate (9 lb/acre) resulted in moderate injury to the peas as evidenced by the visual rating recorded four weeks after treatment. It is interesting to note that Sinox PE did not injure the peas when applied at crop emergence. Randox caused only a slight amount of injury which was considered to be of no serious detriment to the pea growth.

Weed control: Wiregrass was not controlled at the low rates of Sinox PE and spiny amaranth was not controlled satisfactorily with the low rate of Randox. The control of popolo and garden spurge was excellent with all of the herbicide formulations used under the test conditions which prevailed.

EXPERIMENT NO. 6

(Permanent file copy WC-5)
University Campus Farm Field Mid-J

Crop:	Pea (Manoa Sugar B6).
Experimental design:	Randomized complete block, 4 replications, plot size 5 ft. × 20 ft.
Experimental procedure:	Field preparation Feb. 14, 1962; Date of sowing Feb. 23; Treatment applications–Herbicides applied to treatment numbers 3 to 6 on March 2 (at emergence), and treatment numbers 7 to 14 on March 14 when peas were 5 inches in height with 5 to 7 nodes.
Climatic conditions:	*Rainfall (.10 inch and greater):* Feb. 26 to March 1–heavy rain, March 4–.25, 6–.38, 12–.19, 13–.25, 14–.69, 15–.25.
	Irrigation: Furrow irrigated on Feb. 23.
Weed species:	Most prevalent: *grasses*–wiregrass, lovegrass; *broadleaf*–purslane.
	Trace amount: *broadleaves*–spineless amaranth, spiny amaranth, sow thistle, and apple of Peru.
Results:	See table 6.

Discussion and Summary:

Crop tolerance: The compound used in this test severely injured the peas when sprayed over the plants which were approximately 5 inches in height, but caused no injury when applied at crop emergence. Crop phytotoxicity is often encountered under island conditions when herbicides are applied over the crop foliage in hopes of obtaining selectivity. An over-the-plant spray of Sinox PE or Premerge is a standard recommendation on canning peas throughout the temperate regions of mainland U.S.A. The edible podded pea used in this experiment differs from the canning pea only in a recessive gene for quality.

Weed control: Poor grass control was observed at the rates of herbicide used, but surprisingly excellent weed control of the broadleaved weed species was obtained at the low rates of Sinox PE or Premerge.

TABLE 6. Pea tolerance and weed injury ratings, University Campus Farm Field Mid-J, Experiment No. 6[1]

Treatment (pounds per acre)		Pea injury rating	March 27, 1962			
			Furrow		Shoulder	
			Grasses	Broadleaves	Grasses	Broadleaves
1. Check, uncultivated		1.0	1.0	1.0	1.0	1.0
2. Check, cultivated		1.0	5.0	5.0	5.0	5.0
3. Sinox PE 1½ lb.	at emergence	1.0	2.8	5.0	2.3	4.8
4. Sinox PE 2¼ lb.	at emergence	1.0	3.0	5.0	2.8	5.0
5. Sinox PE 3¾ lb.	at emergence	1.3	3.8	5.0	3.8	5.0
6. Premerge 2¼ lb.	at emergence	1.0	3.0	5.0	2.0	4.8
7. Sinox PE 1½ lb.	Peas 5 inches in height	2.8	1.0	5.0	1.3	4.3
8. Sinox PE 2¼ lb.	Peas 5 inches in height	3.3	1.5	4.8	2.0	4.8
9. Sinox PE 3¾ lb.	Peas 5 inches in height	3.8	2.0	5.0	3.8	5.0
10. Premerge 2¼ lb.	Peas 5 inches in height	3.5	1.3	4.5	2.0	5.0
11. Sinox PE 1½ lb.	Peas 5 inches in height	2.3	1.0	5.0	1.8	4.5
12. Sinox PE 2¼ lb.	Peas 5 inches in height	3.5	1.3	5.0	2.5	5.0
13. Sinox PE 3¾ lb.	Peas 5 inches in height	3.8	2.0	5.0	3.5	5.0
14. Premerge 2¼ lb.	Peas 5 inches in height	3.8	1.0	4.8	2.8	5.0
L.S.D. 5%		0.2	0.4	0.4	0.8	0.4
L.S.D. 1%		0.3	0.6	0.6	1.0	0.6

[1]Crop rating: 1—no injury, 2—slight, 3—moderate, 4—severe, 5—dead. Weed rating: 1—no control, 2—slight, 3—fair, 4—good (commercially acceptable), 5—complete.

EXPERIMENT NO. 7

(Permanent file copy WC-37I)
Maui Branch Station (Kula)

Crop: Pea (Manoa Sugar B6).

Experimental design: Randomized complete block, 3 replications, plot size 3 ft. × 12 ft.

Experimental procedures: Field preparation March 31, 1963; Field sowing April 1 and 2, 1963; Treatment applications—Treflan, Dacthal, and Dymid applied on April 4, all others on April 3.

Climatic conditions: *Rainfall (over .10 inch):* April 2—.20, 6—.50, 7—.25, 9—.46, 10—.27, 11—.56, 14—.61, 15—.90, 17—.46, 18—.22, 27—.23, 28—.58, 29—.44, May 5—1.09, 15—2.00, 16—1.39, 17—.74, 19—.34, 28—.27.

TABLE 7. Pea tolerance and weed response to the herbicides, Maui Branch Station, Experiment No. 7

Treatment (pounds per acre)	Pea Response		Weed Control
	Crop rating May 9	Average plant weight (grams) at flowering	Weed rating[1] May 9 (5 weeks)
1. Check, uncultivated	1.0	36.6	2.7
2. Check, cultivated	1.0	37.6	5.0
3. Sinox PE 6 lb.	3.7**	6.4**	4.3
4. Sinox PE 9 lb.	4.3**	5.6**	4.3
5. Randox 6 lb.	2.0**	20.3**	3.0
6. Vegadex 6 lb.	1.3	23.7**	4.7
7. Dacthal 10.5 lb.	1.0	32.2*	3.0
8. Vegadex 4 lb. + Sinox PE 3 lb.	3.3**	8.9**	4.7
9. Treflan 2 lb. (soil incorporated)	2.3**	26.0**	3.3
10. Vegadex 4 lb. + Randox 4 lb.	2.7**	13.4**	4.7
11. Randox 4 lb. + Sinox PE 3 lb.	3.0**	13.2**	3.3
12. Dymid 6 lb.	3.3**	4.7**	5.0
L.S.D. 5% (1%)	0.9(1.3)	3.2(5.7)	2.3(–)

[1]Weed rating: 1–no control, 2–slight, 3–fair, 4–good (commercially acceptable), 5–complete. Crop rating: 1–no injury, 2–slight, 3–moderate, 4–severe, 5–dead.

*Significantly different from the cultivated check at the 5% level (**1% level).

Weed species: Most prevalent: *grass*–foxtail; *broadleaves*–swinecress, smooth amaranth, sow thistle, apple of Peru.

Results: See table 7.

Discussion and Summary:

Crop tolerance: With the exception of Dacthal, severe injury was observed on the peas from the herbicides. Vegadex and Treflan appeared to be the safer herbicides of those inflicting severe injury. The peas in this experiment were grown at a 2,000-foot elevation under cold temperatures. It is postulated that the cool temperatures slowed the pea growth such that they were very vulnerable to herbicide injury.

Weed control: The grass was controlled with all of the herbicides; however, poor broadleaved weed control was obtained with Randox, Dacthal and Treflan. The three herbicides mentioned are especially weak on swinecress which predominated in the experiment.